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Assessing the protection provided by facepiece filtering respirator: New model involving spherical porous layer with annular peripheral opening

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Abstract

© Taiwan Association for Aerosol Research.The penetration of aerosol particles inside a facepiece filtering respirator (FFR) was investigated using a novel model, which involved a spherical porous layer representing a filter and an annular peripheral opening representing a faceseal leakage. The model utilized a two-dimensional laminar incompressible flow in a free space and porous zones that are numerically solved by a computational fluid dynamic code FLUENT. Following the model validation, the efficiency of an FFR with an annular faceseal leakage opening was investigated as a function of the inhalation flow rate, particle size, and the ratio of the leak-to-filter areas. The filter material permeability was determined for a conventional N95 filter medium. It was found – for two inhalation flow rates (Qi = 30 and 85 L min–1) and three particle diameters (dp = 50 nm, 100 nm and 1 μm) – that once the faceseal leakage area exceeded 0.1% of the total surface of an N95 facepiece, the respirator was unable to offer the 95% protection – the minimum level that should be provided by its filter. It was demonstrated that under certain leakage condition (partially determined by the inhalation flow rate), the respirator protection level becomes independent on the particle size; furthermore, it is not anymore affected by the efficiency of its filter, and is only influenced by the size of the faceseal leakage.

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Keywords

CFD, Faceseal leakage, Filter, Penetration, Respiratory protection